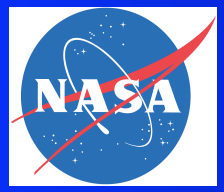

Gravity Wave Properties and Propagation derived from AIRS radiance variances

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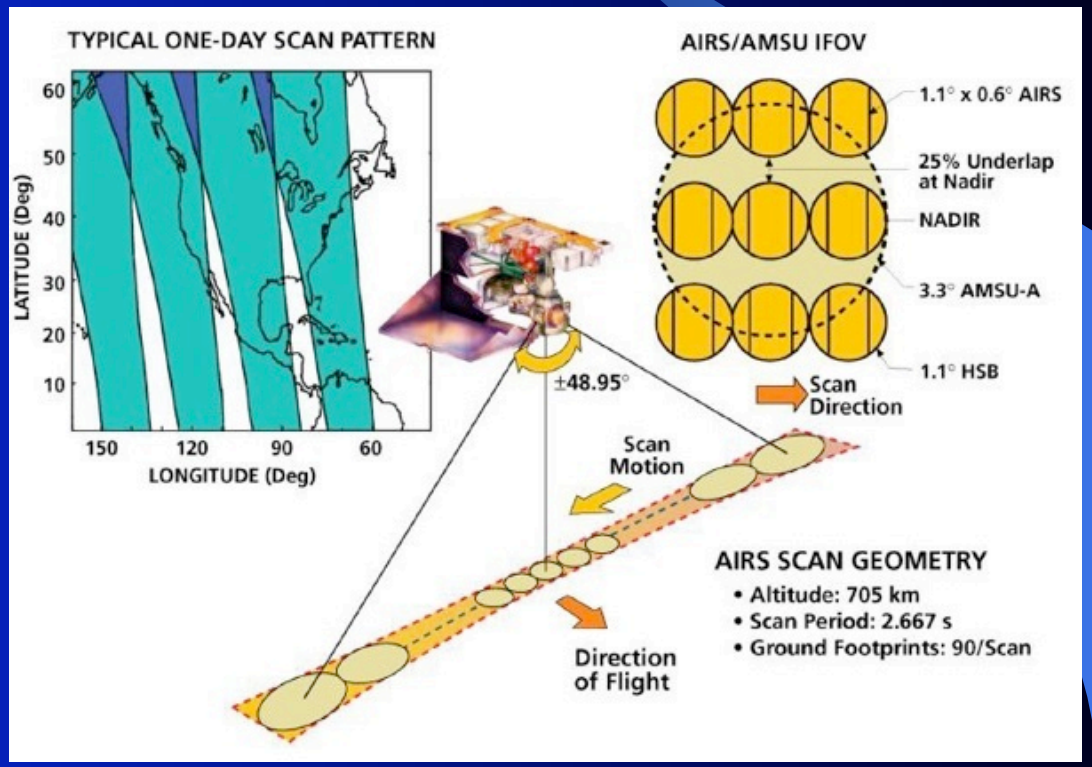
AIRS (Atmospheric Infrared Sounder) on NASA Aqua

Footprint: 1.1° x 0.6° (13.5 km x 7.4 km)

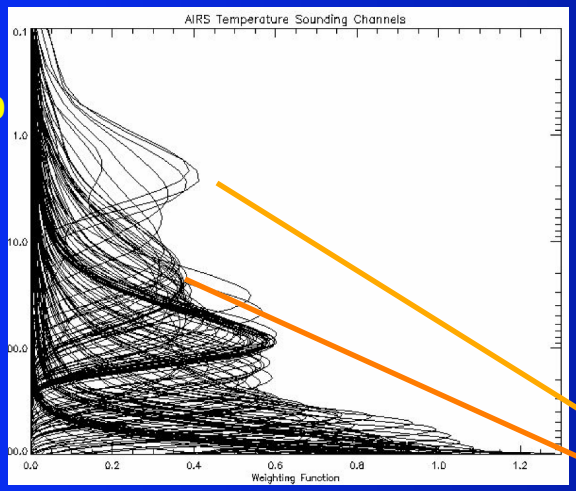
Scan range: ±48.95°

Compared to AMSU-A, the detectable frequecy range increases

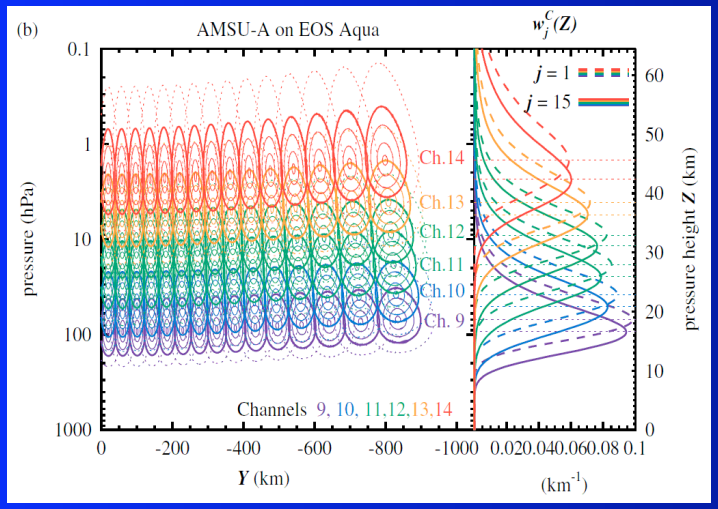
$$\frac{\lambda_z}{\lambda_h} \approx \frac{\omega}{N}$$



Pressure Height



- AIRS Weighting function



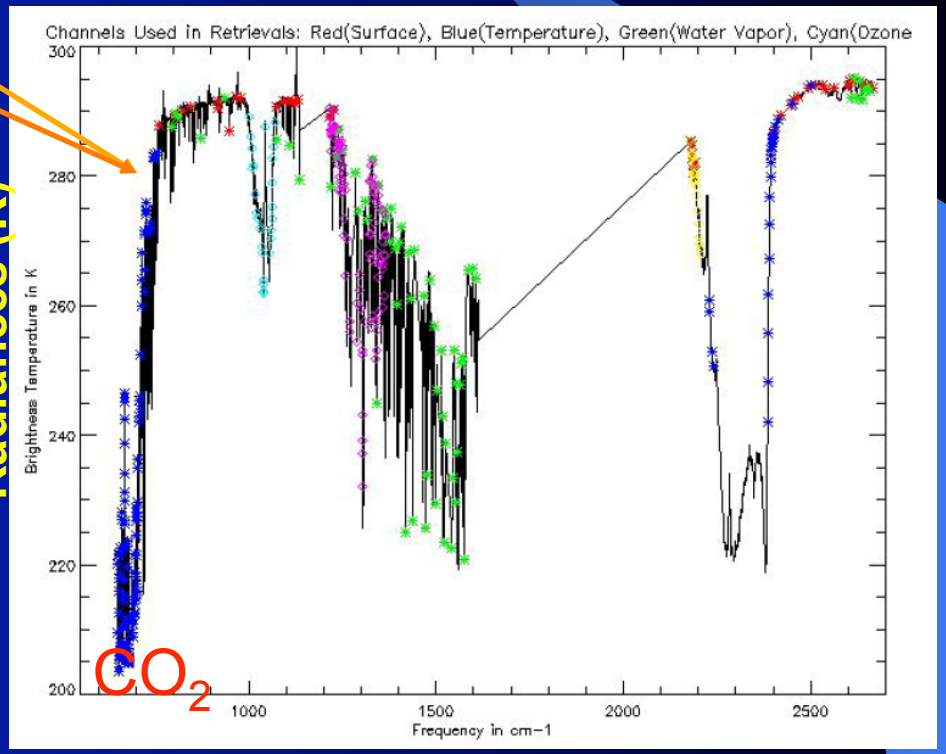
AMSU-A Weighting function

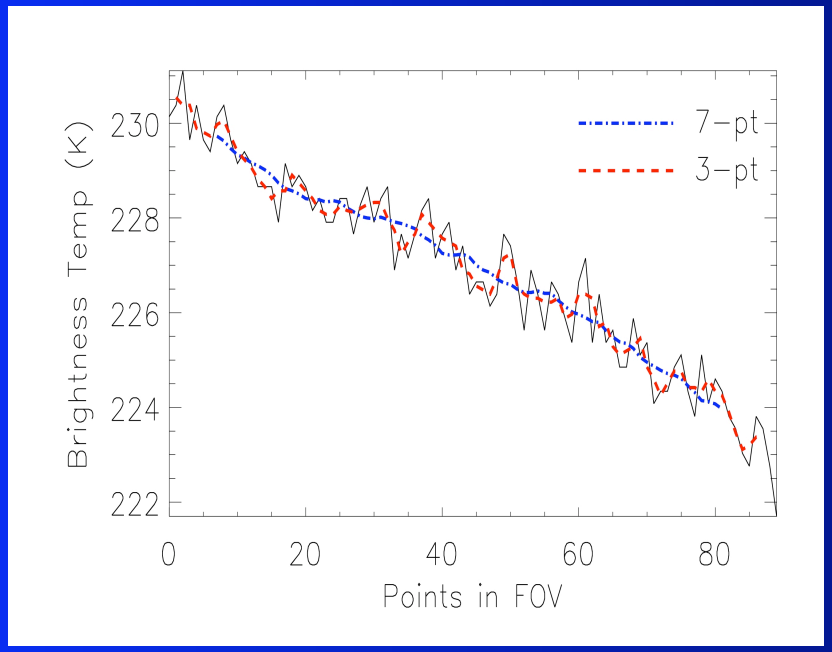
(Eckermann et al., 2007)

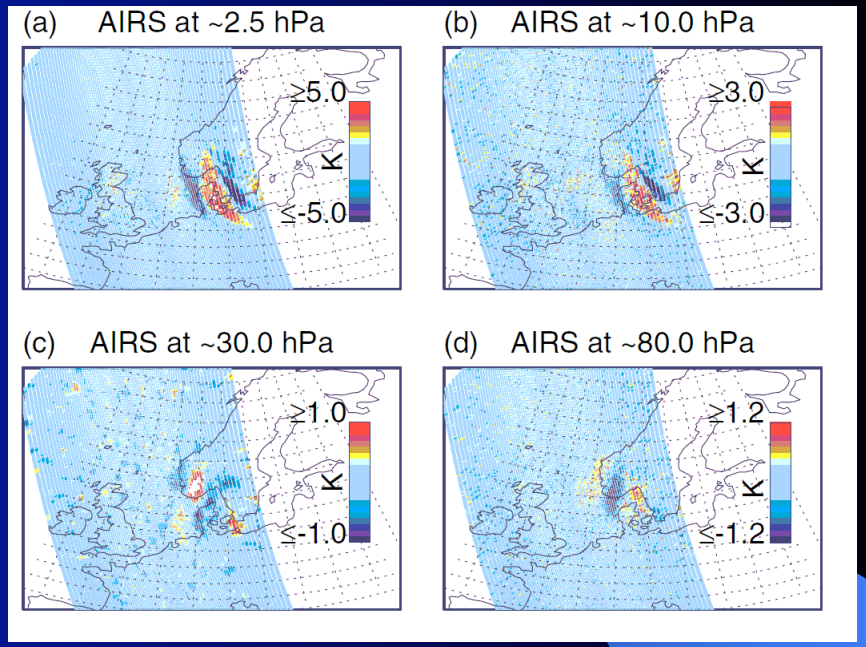
Pressure height (hpa)

2, 2.5, 3, 4, 7, 10, 20, 30, 40, 60, 80, 100, 200, 400, 800, 1000

Radiances (K)







- Gravity wave information are derived from the perturbation part of the brightness temperature

$$\sigma^2_{tot} = \sigma^2_{GW} + \sigma^2_{noise}$$

Computed from 7-pt perturbations

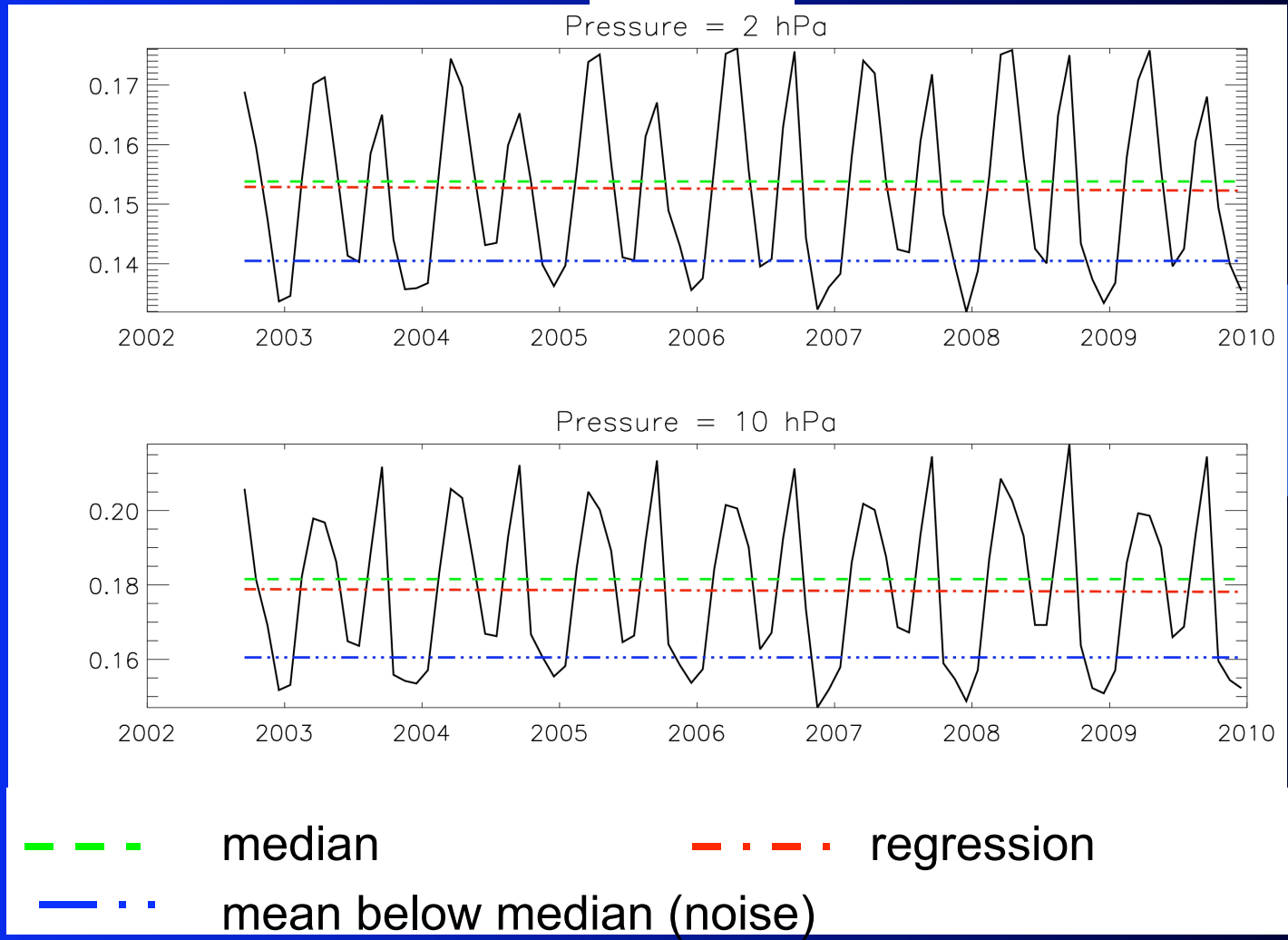
Estimated from 3-pt perturbations

A gravity wave event observing at different heights

(Eckermann et al., 2007)

Instrumental noise from 3-pt perturbations

σ^2_{noise}



AIRS Ch 75

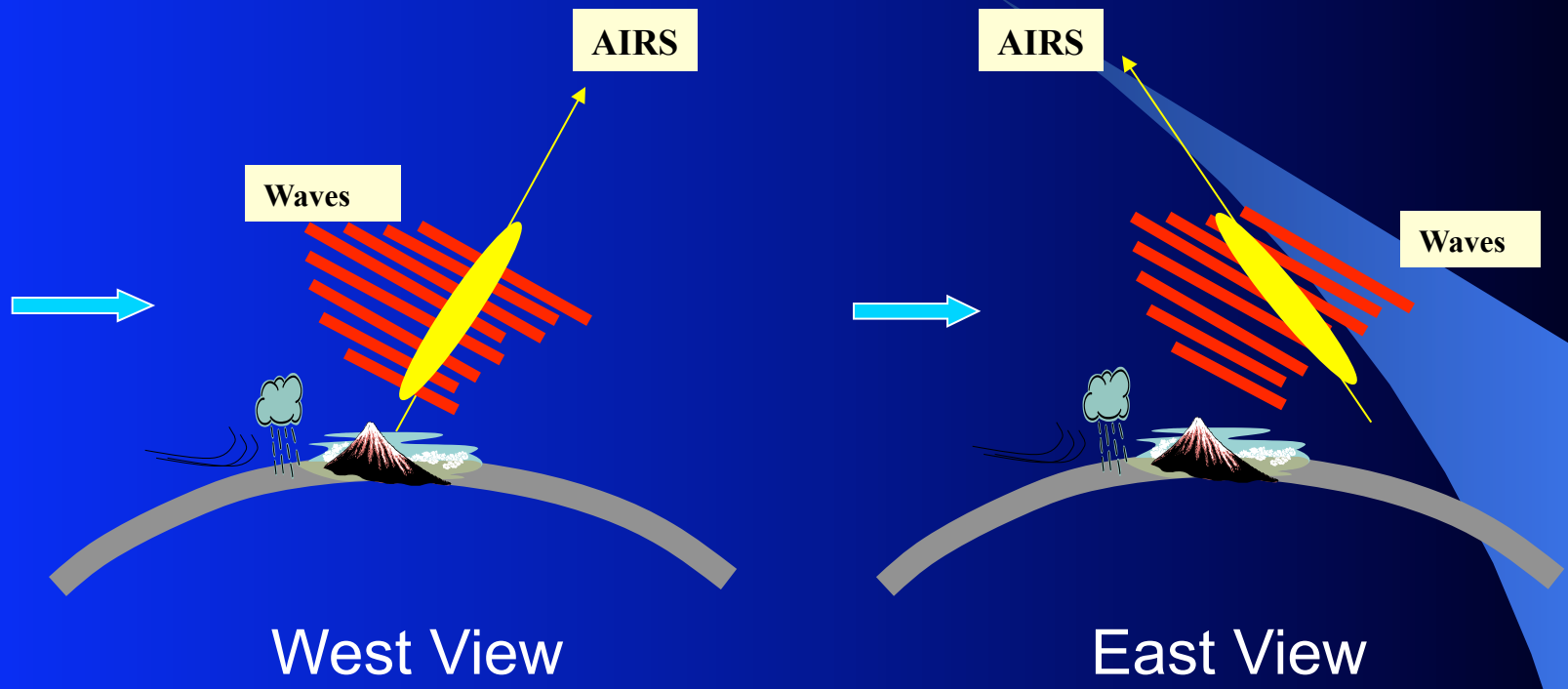
AIRS Ch 79

median

regression

mean below median (noise)

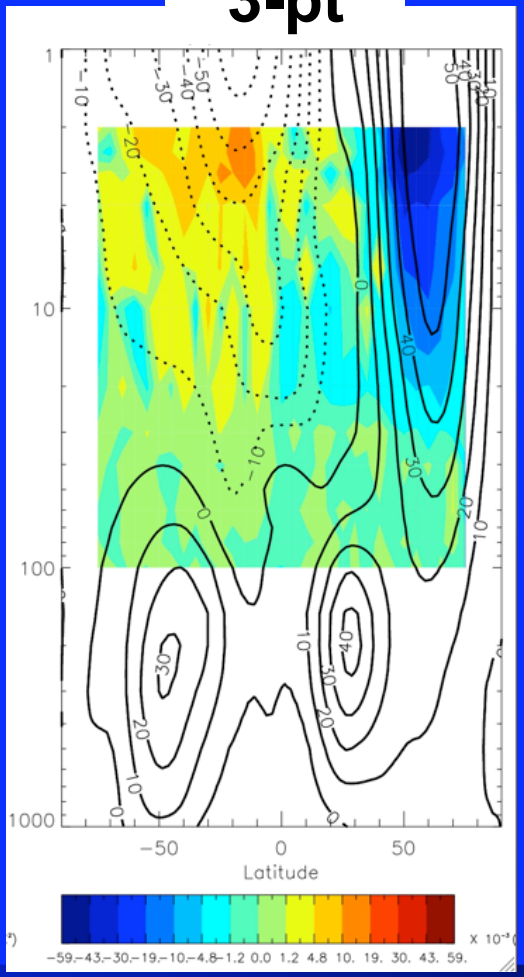
Wave smearing effect



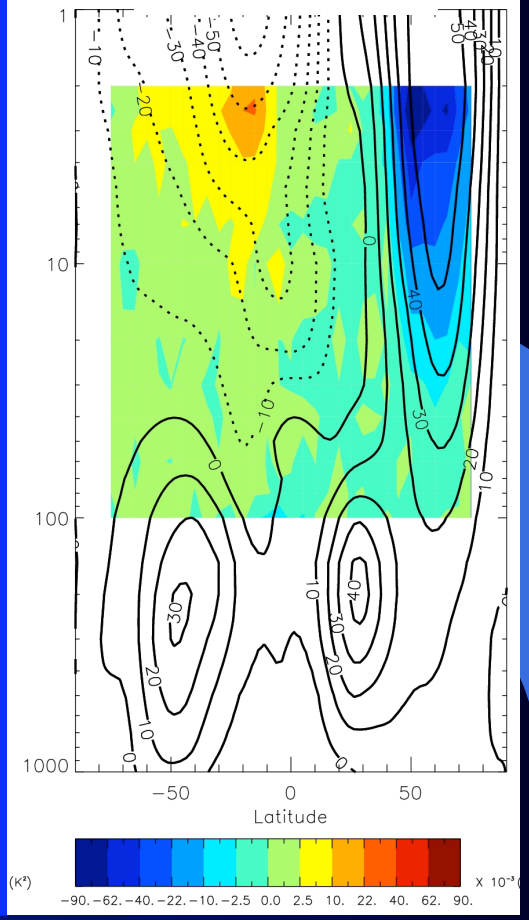
- East - West: > 0 eastward propagation
  < 0 westward propagation

Latitudinal distribution

3-pt



7-pt East-West



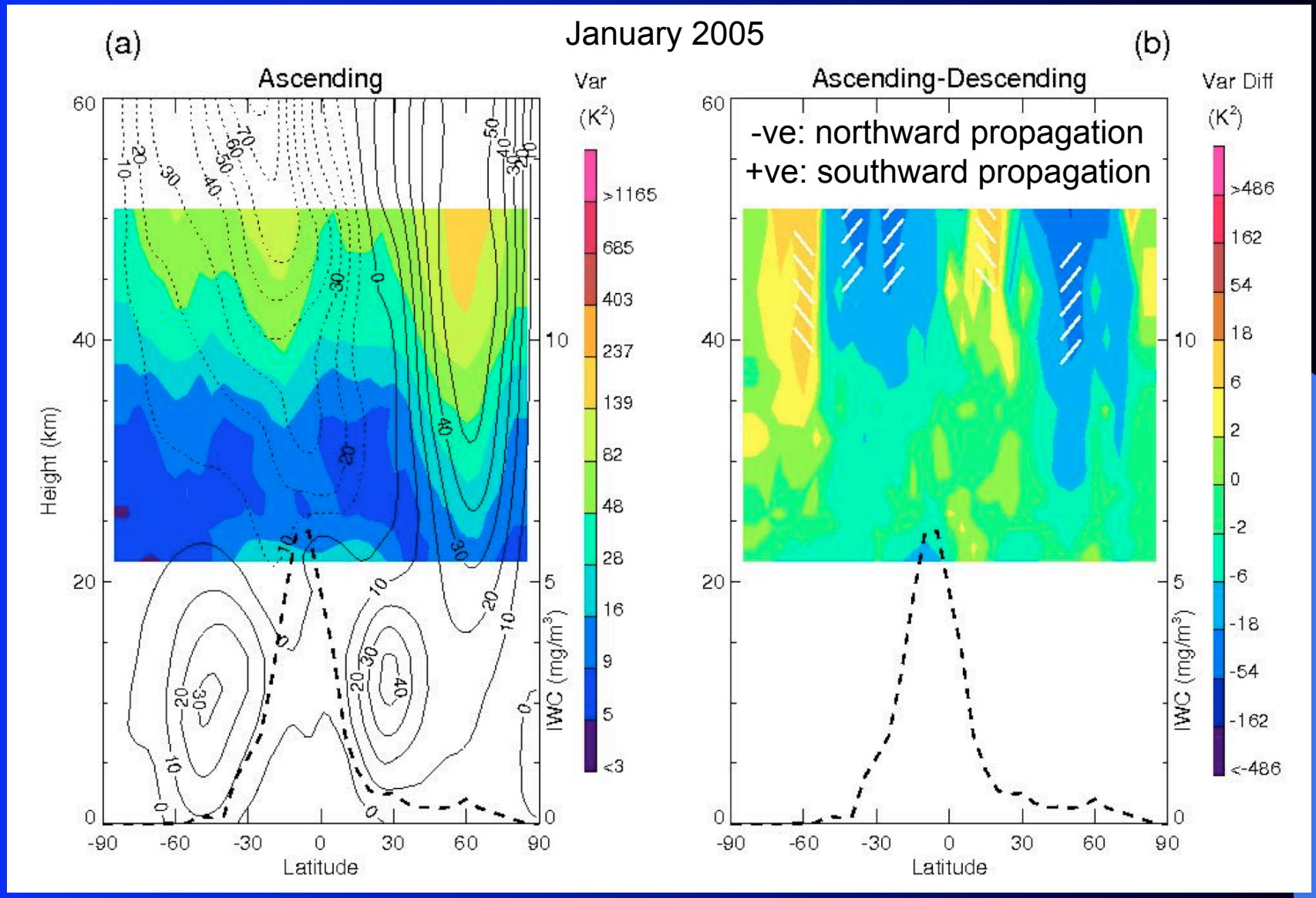
- January, 2005

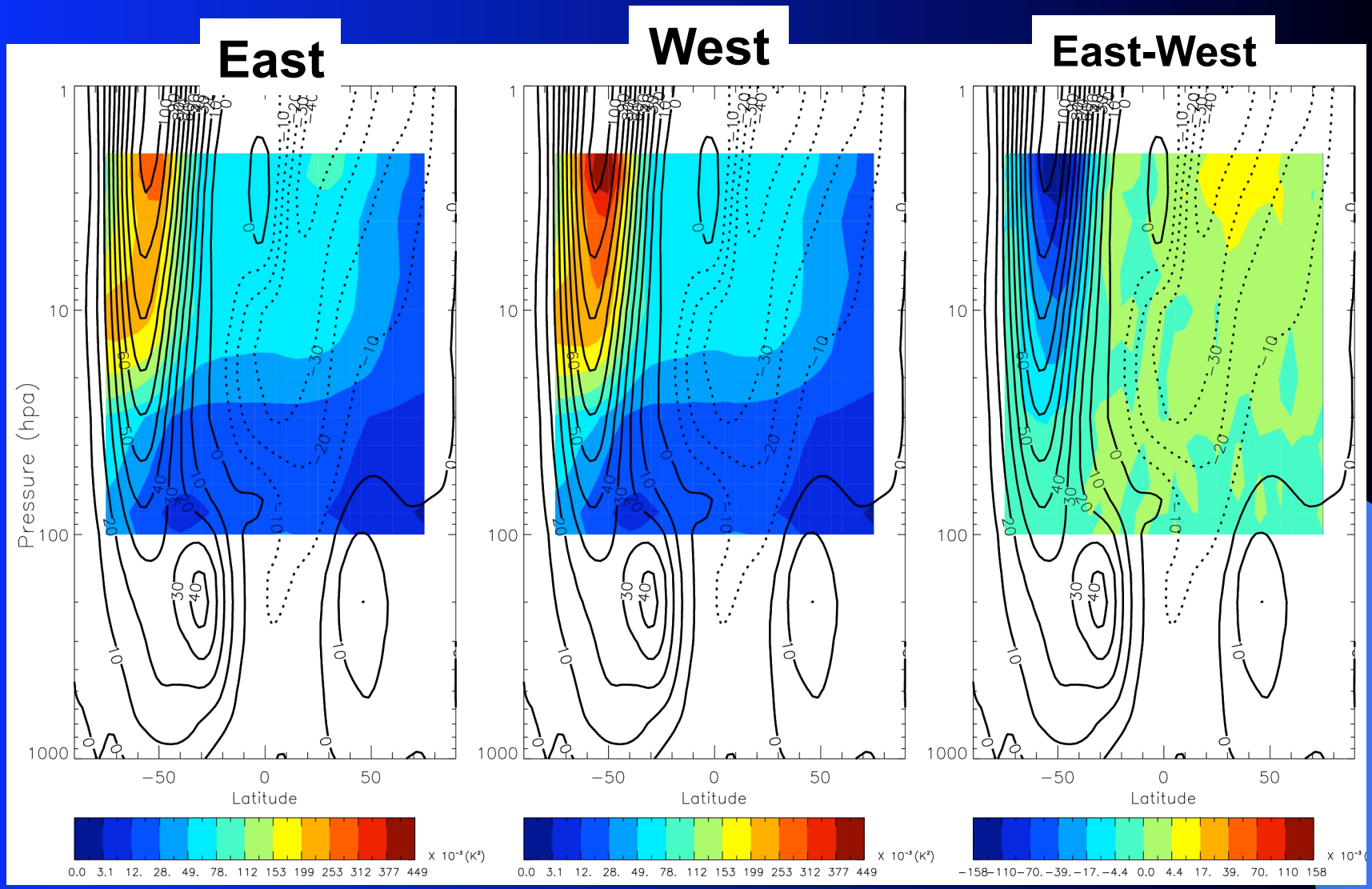
-ve: westward

+ve: eastward

Aura MLS North-South differences

(Wu and Eckermann 2008)

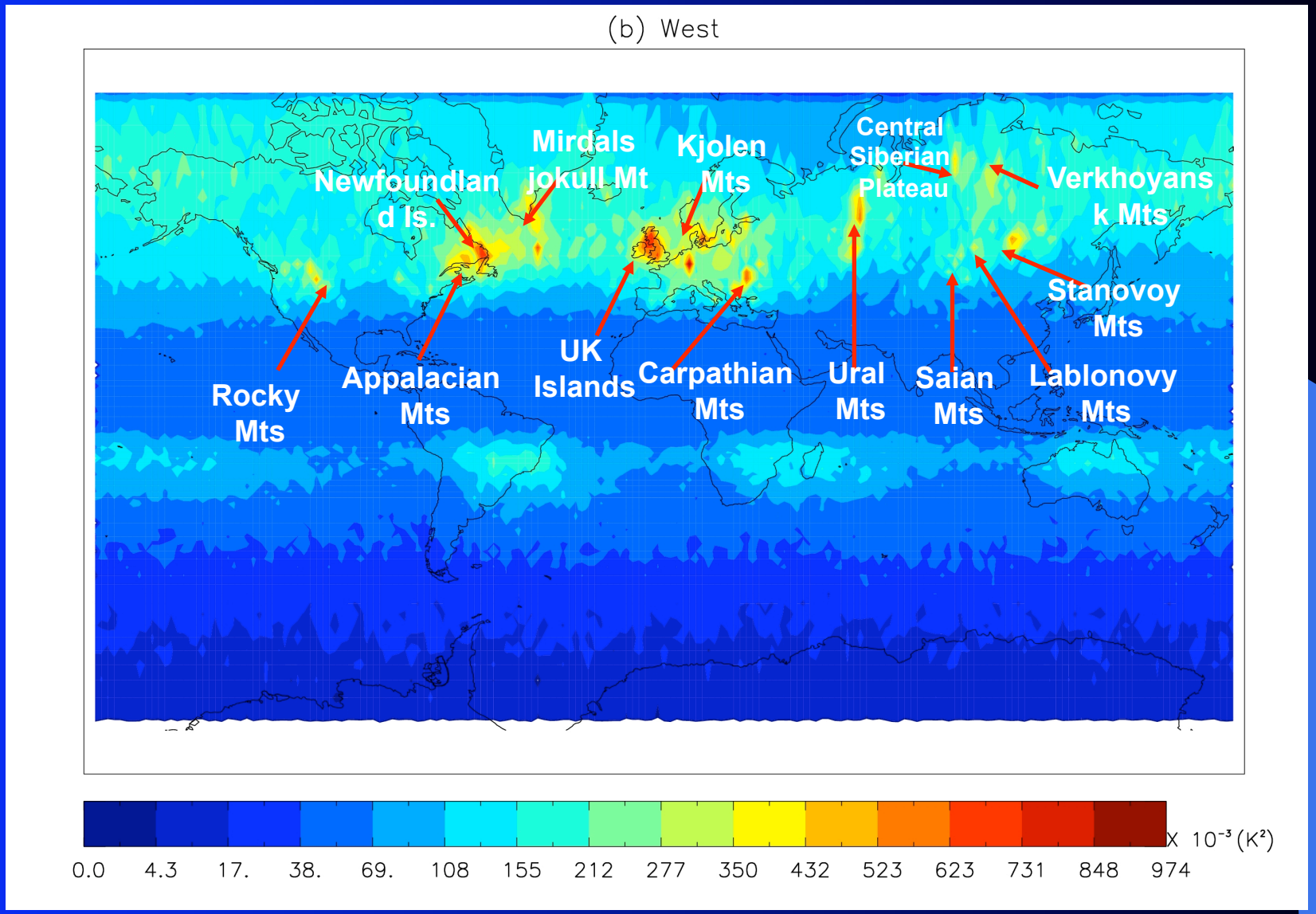



East
West
East-West
Pressure (hpa)
1
10
100
1000
−50
0
50
Latitude
0.0 3.1 12. 28. 49. 78. 112 153 199 253 312 377 449
X 10⁻³ (K²)
−158 −110 −70. −39. −17. −4.4 0.0 4.4 17. 39. 70. 110 158

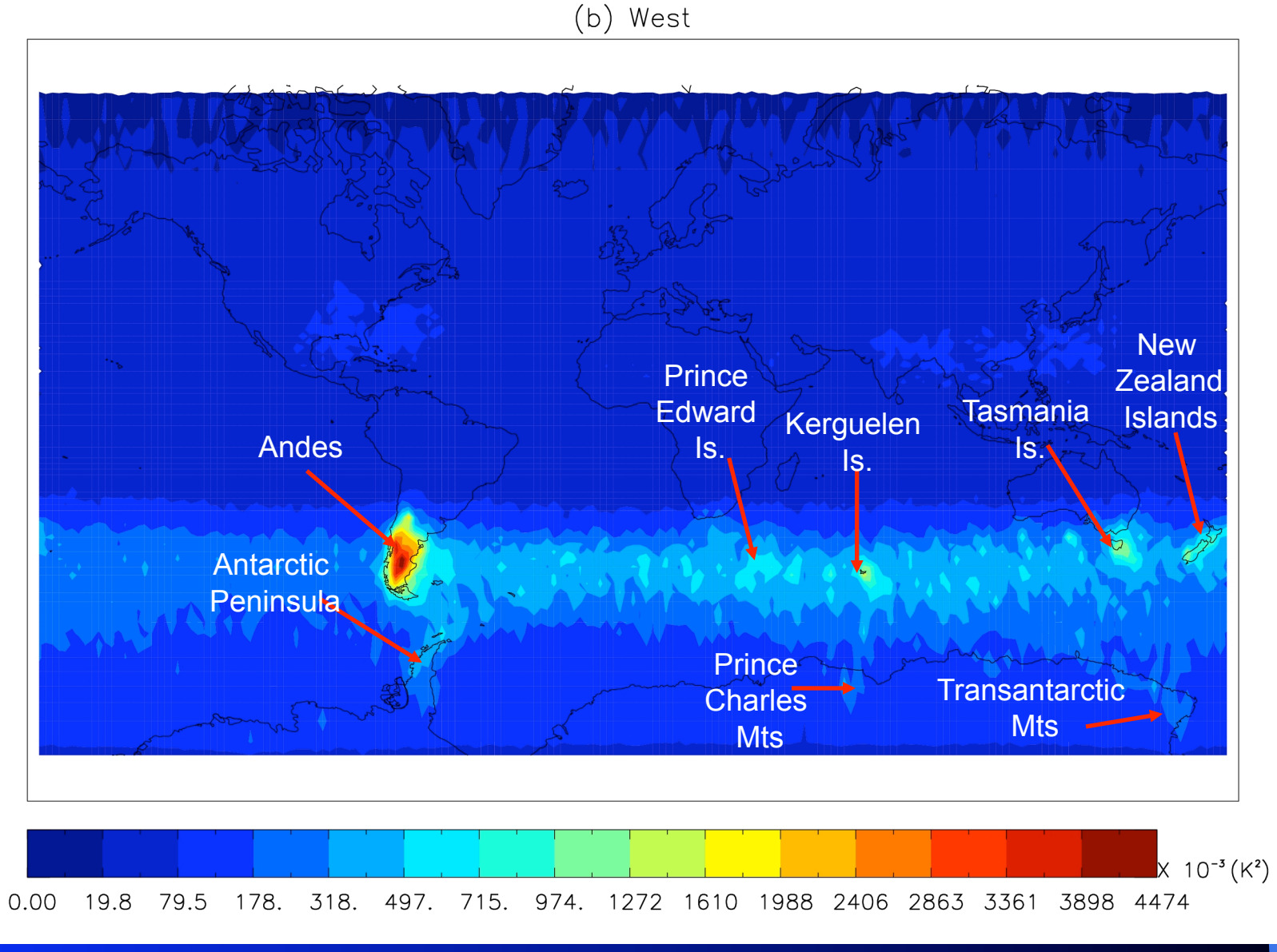
- July, 2005

Spatial distribution - orographic gravity waves

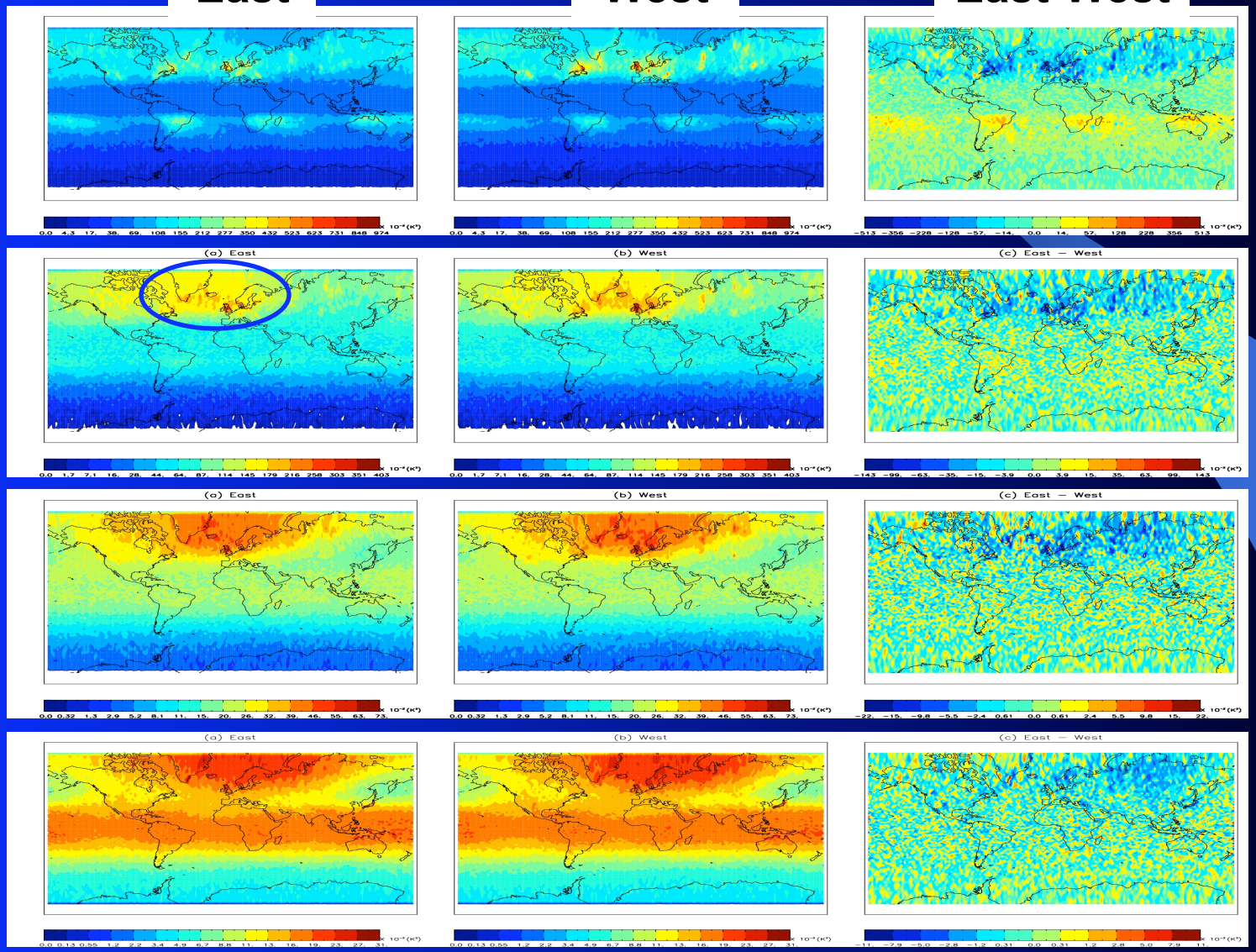
2.5 hpa, January (2002 - 2009 mean), west view



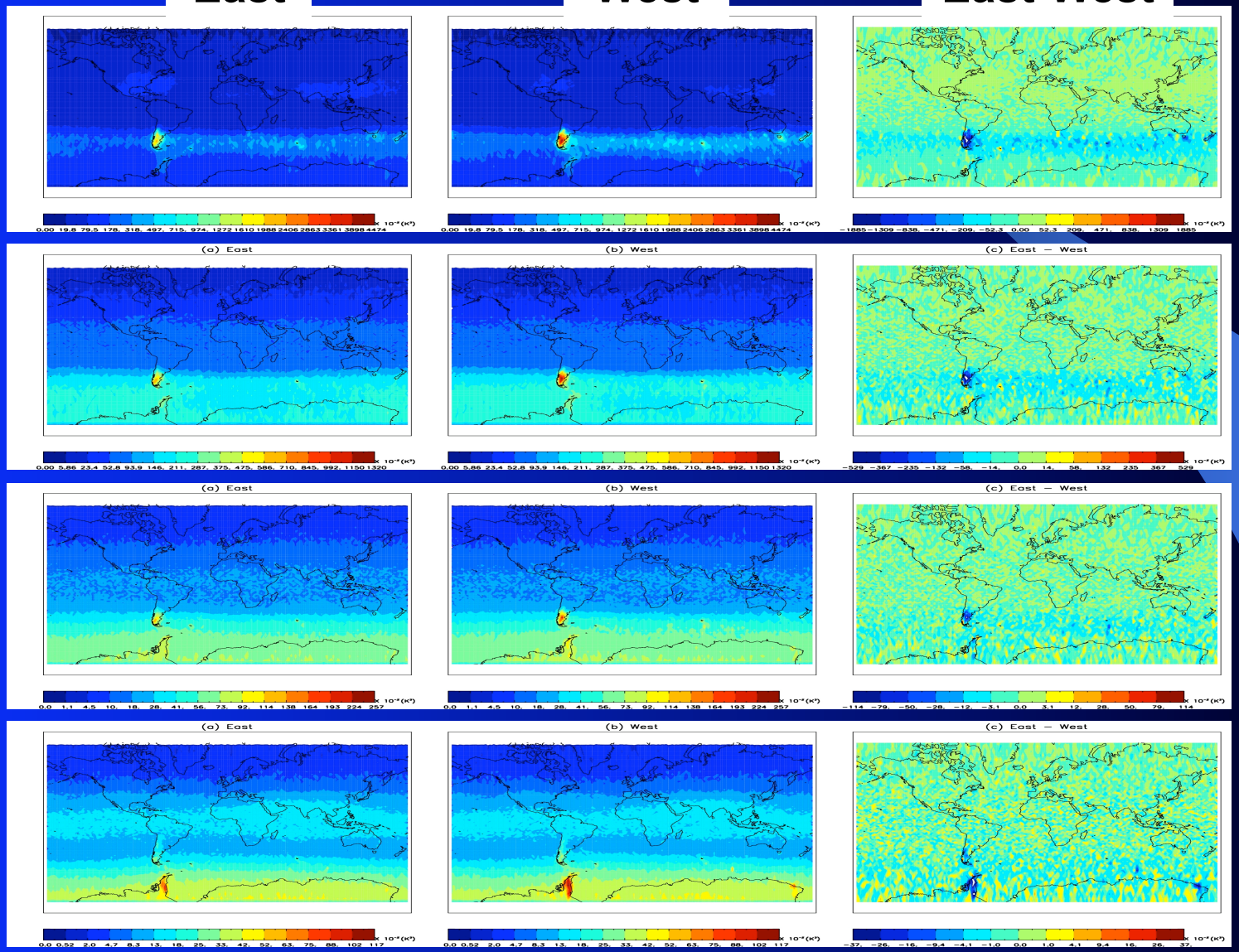
2.5 hpa, July (2002 - 2009 mean), west view



Spacial distribution at various altitudes (Jan., 2002 - 2009)



Spacial distribution at various altitudes (July, 2002 - 2009)

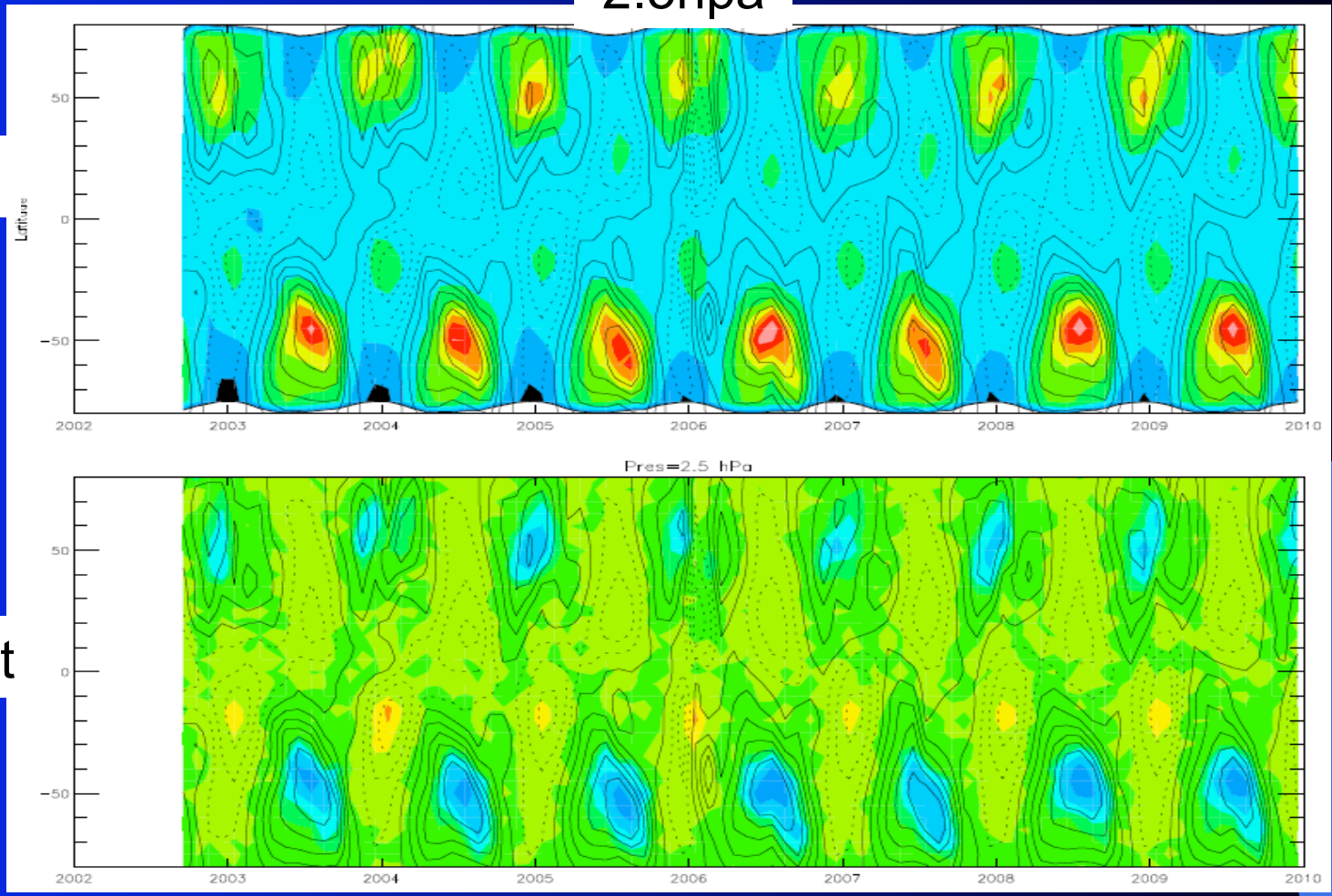


Temporal variations at different altitudes

2.5hpa

variance

East-west



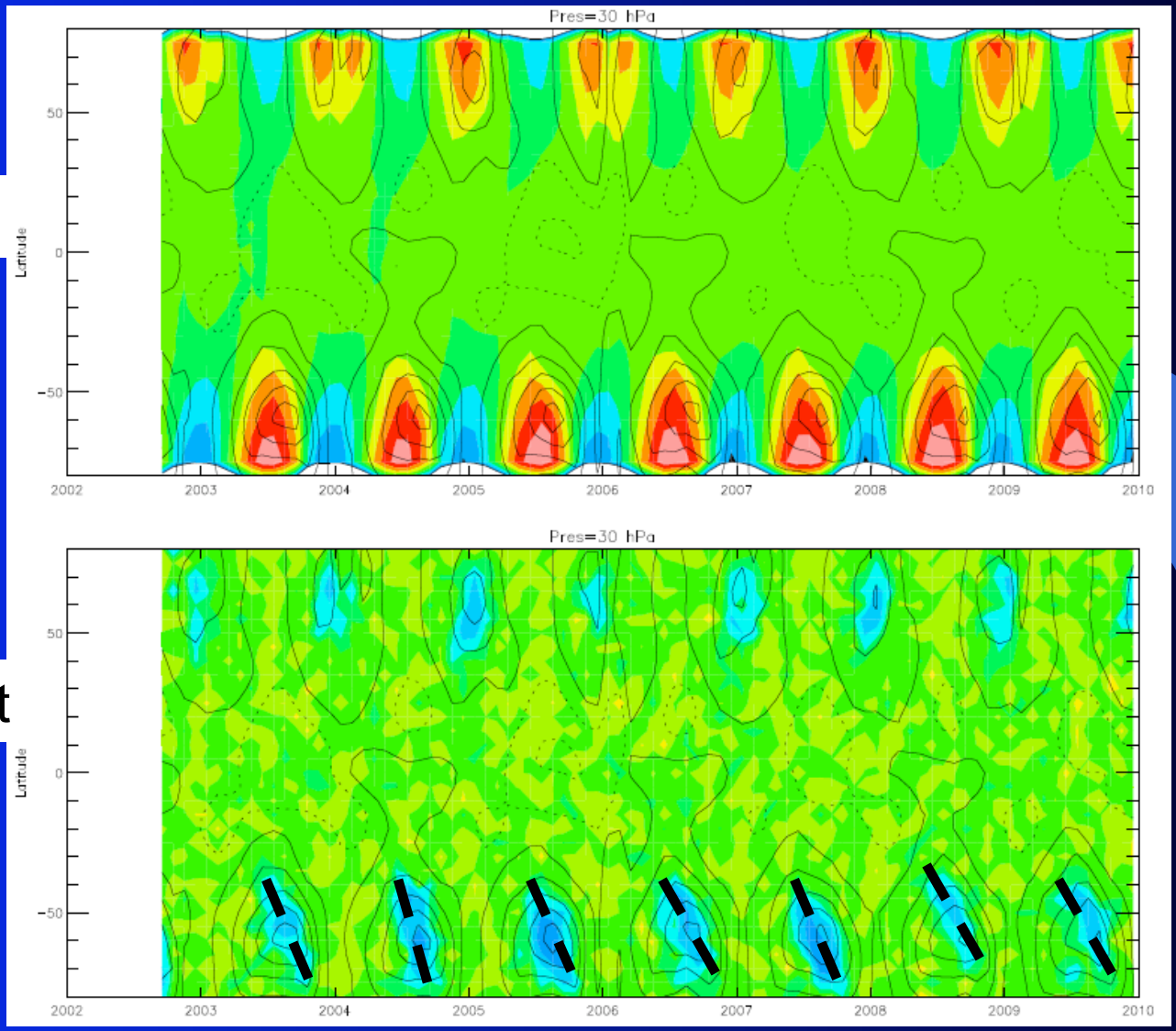
- Convective signals are stronger during austral summers
- Both amp. and the propagation direction are closely related with zonal wind in the Southern Hemisphere

30hpa

SSW SSW SSW

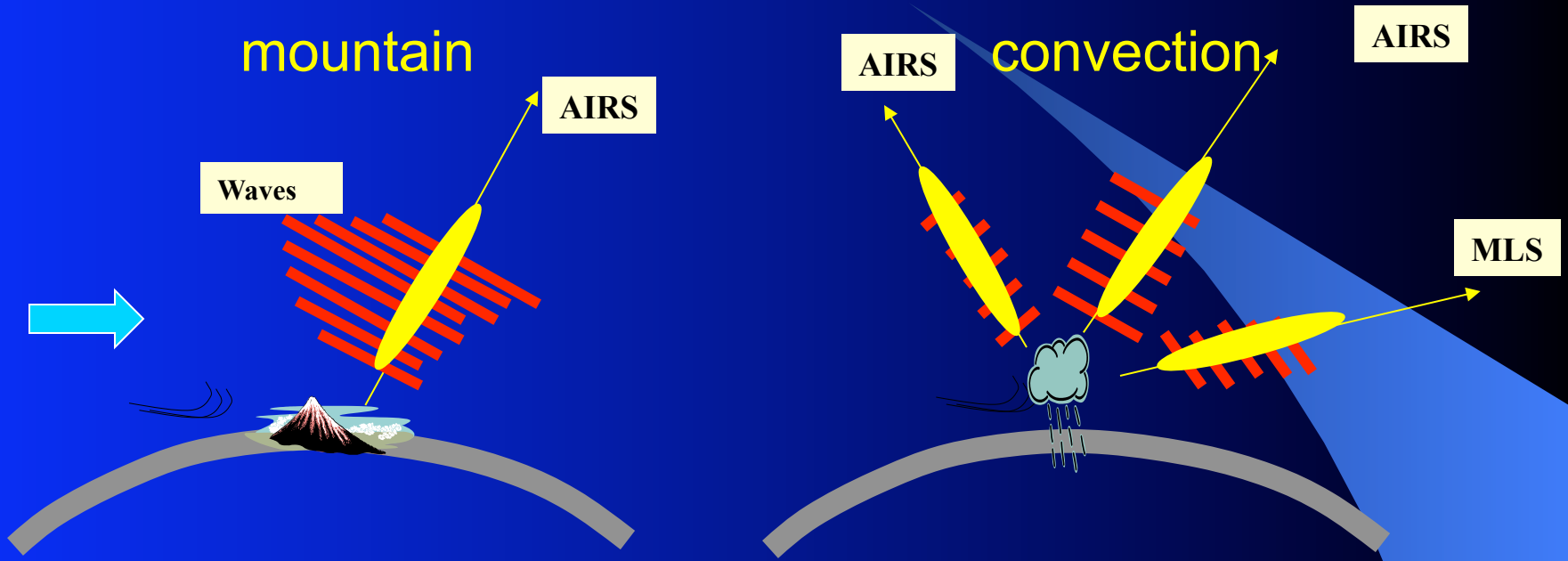
variance

East-west



- SSW: sudden stratospheric warming

Similar and different features of GWs observed by AIRS and MLS



AIRS

- λ_z/λ_h ~1
- East-west scan

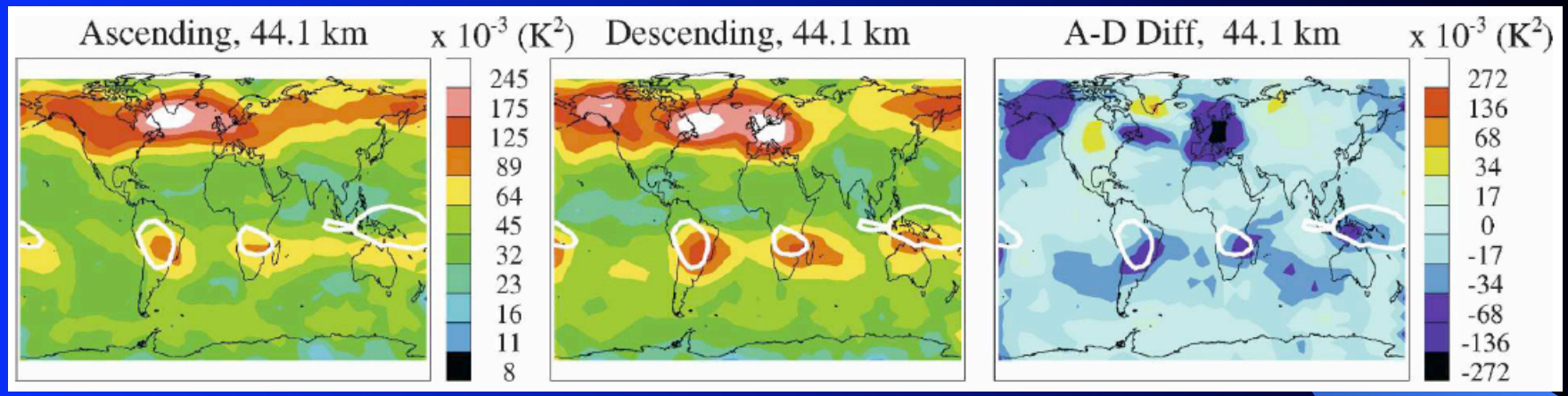
MLS

- λ_z/λ_h ~0.1
- North-south scan

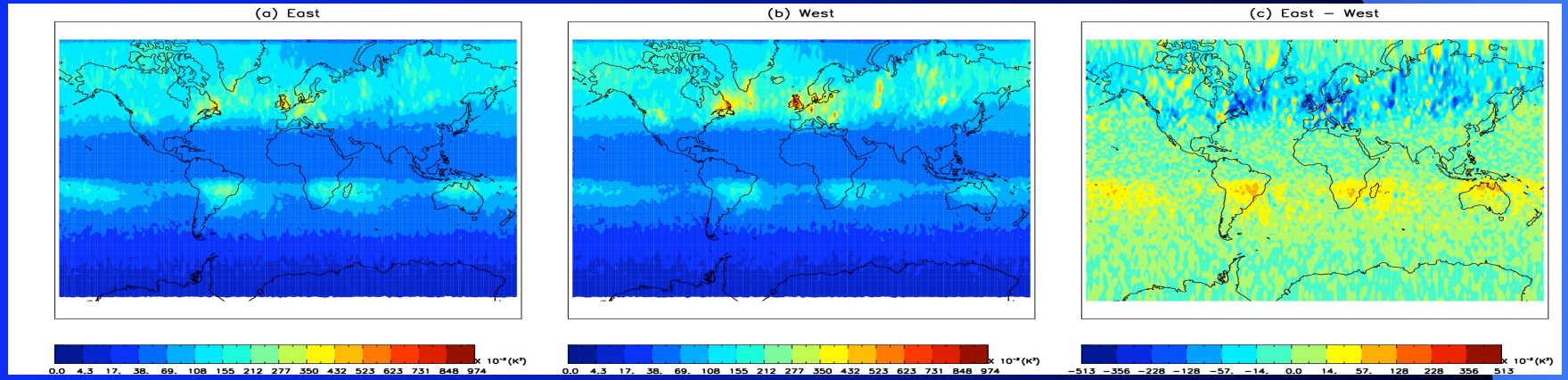
January, 2.5 hpa

MLS

(Wu and Eckermann, 2008)



AIRS

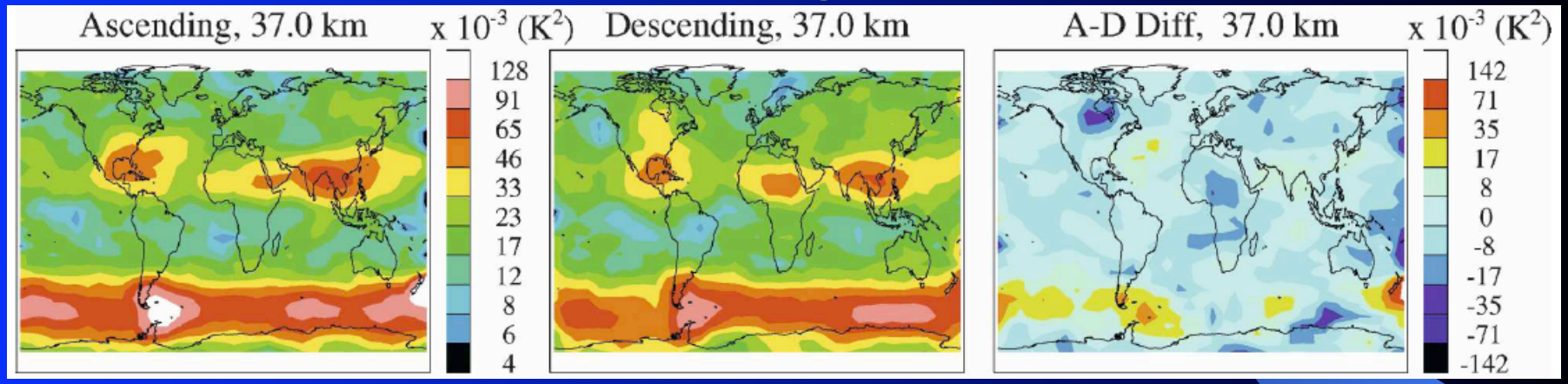


- Mountain signals are much more delicate in AIRS

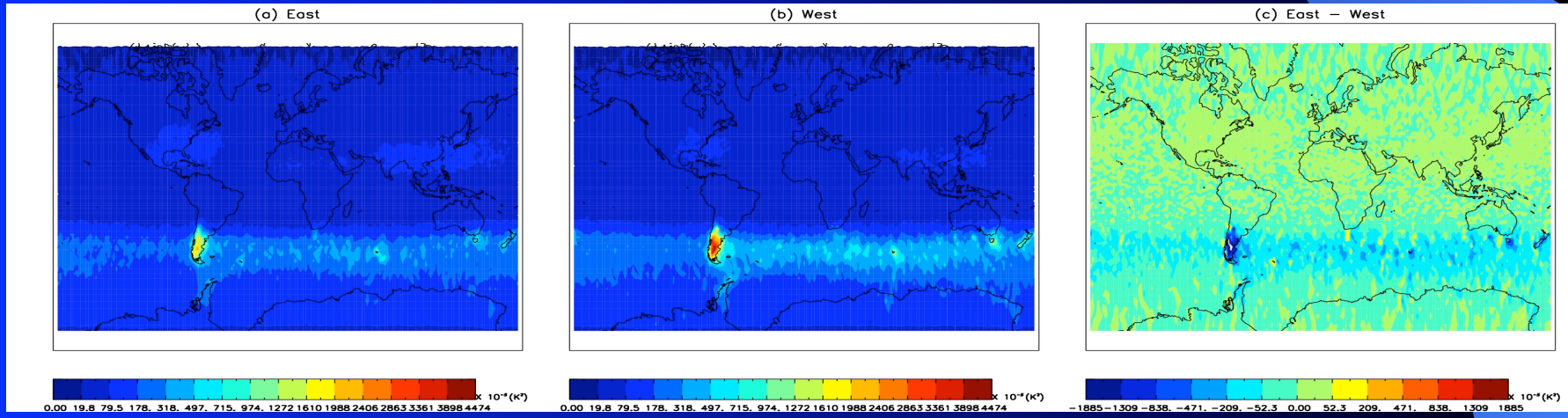
July, 2.5 hpa

MLS

(Wu and Eckermann, 2008)

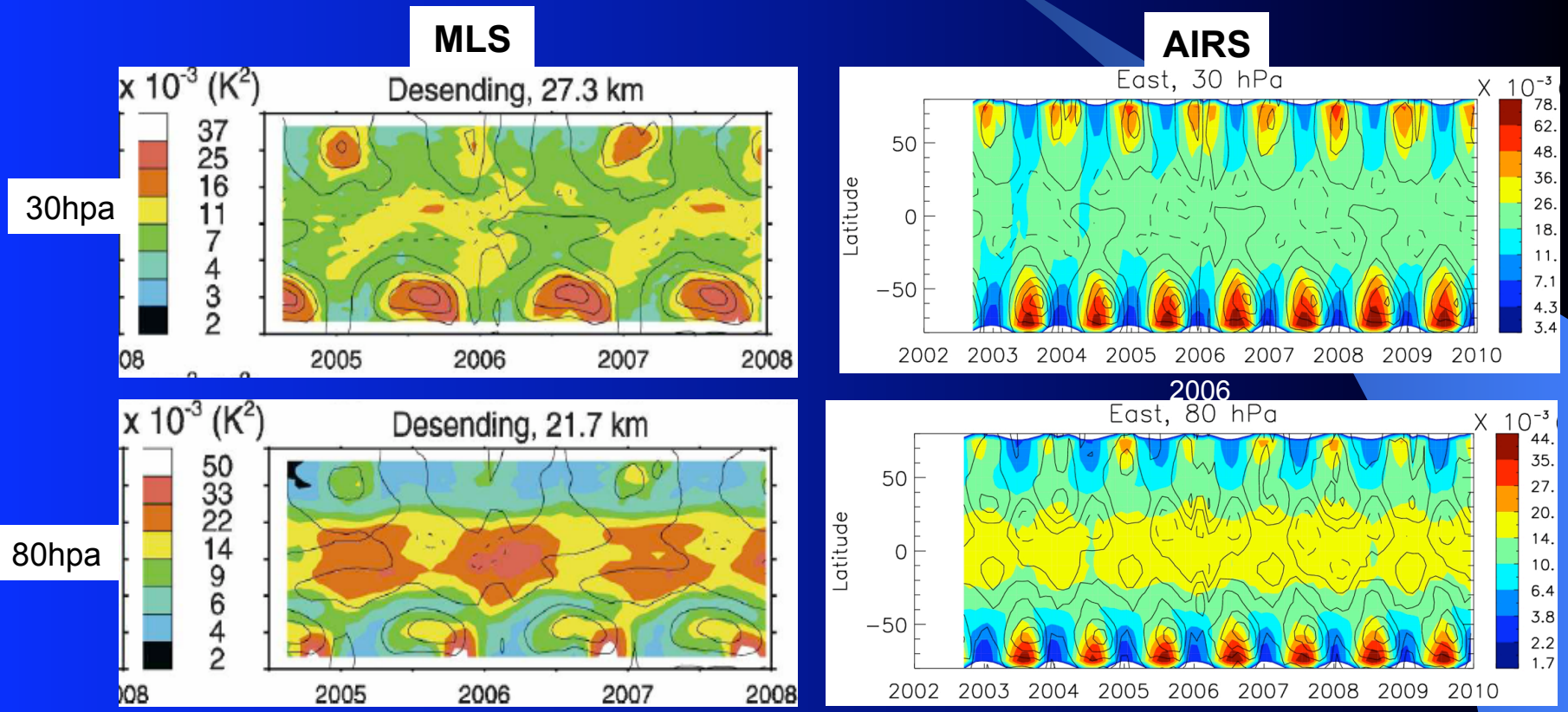


AIRS



- Mountain signals are much stronger in AIRS
- Convective signals are comparable

- QBO signals in MLS, but not in AIRS



(Wu and Eckermann, 2008)

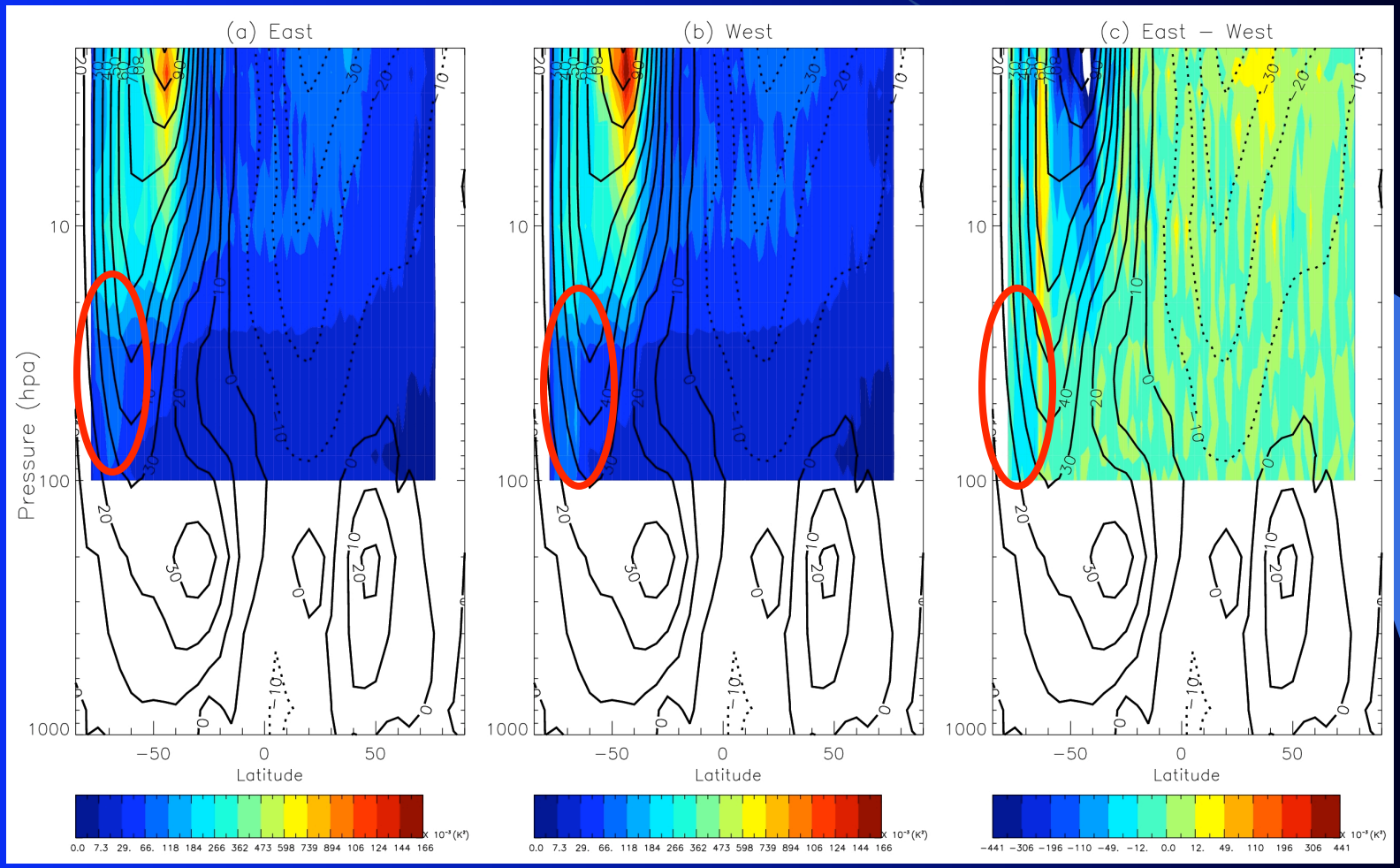
Conclusion Remarks

- The radiance variances derived from AIRS are consistent with GW climatology in terms of wave growth and propagation with height
- East - West viewing differences provide information on wave propagation asymmetry in the zonal propagation direction
- AIRS and MLS together provide a full picture of wave propagation in the zonal and meridional directions
- Compared with MLS, the magnitudes of mountain GWs observed by AIRS are stronger, whereas those of convective waves are comparable but with little QBO.

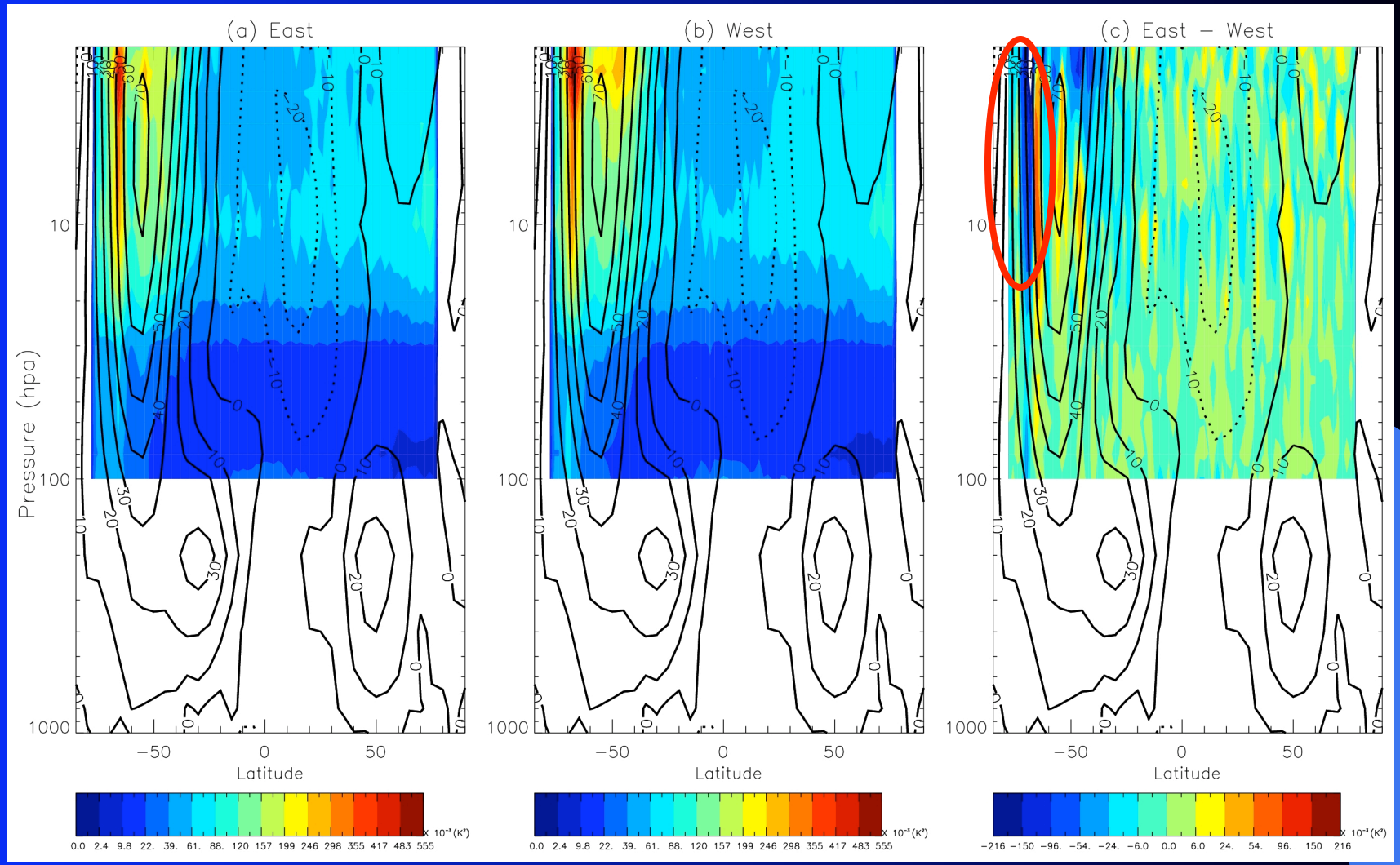
Future works

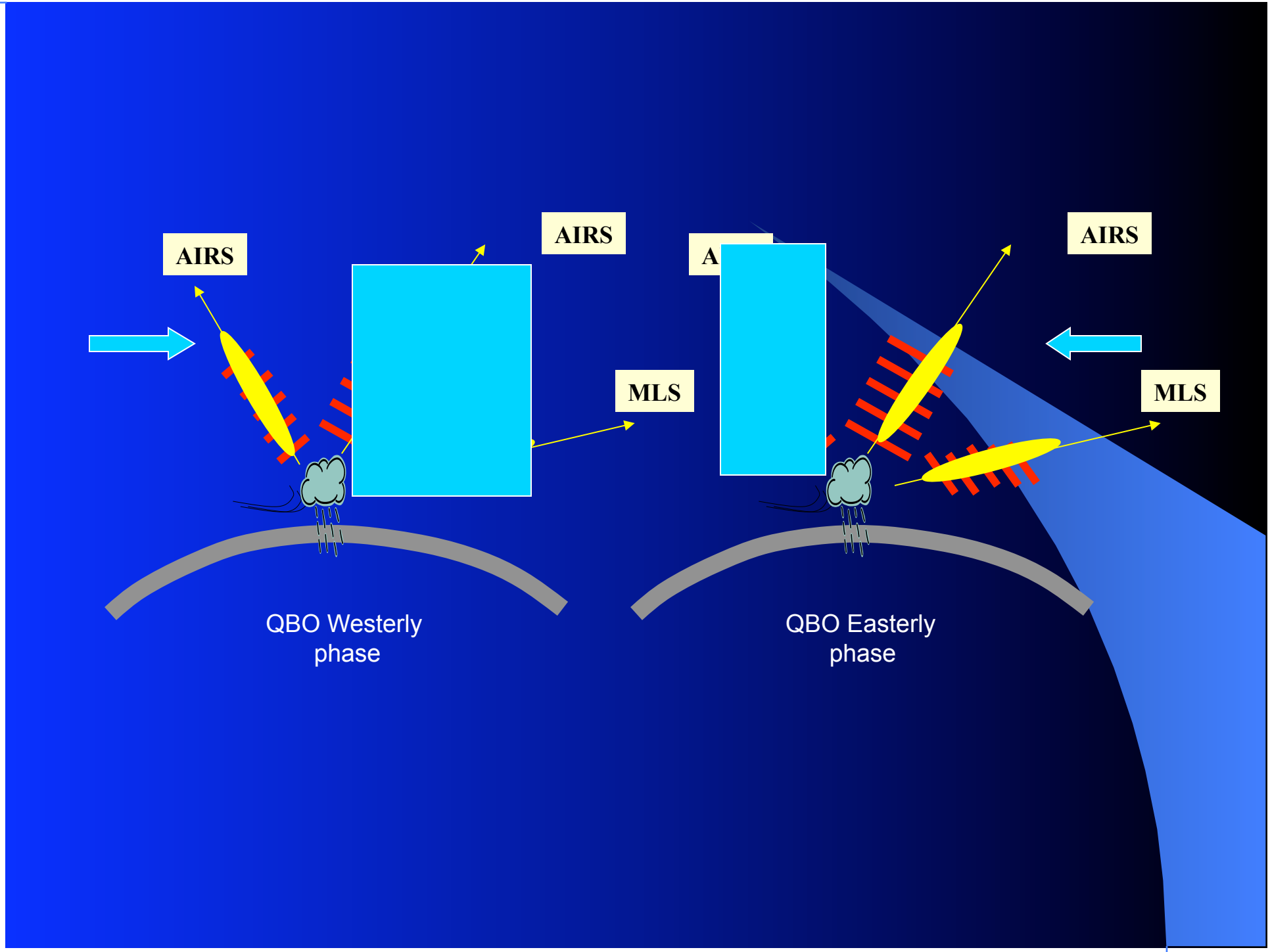
- Need a better noise estimation: empirically vs. the calibration?
- Is the enhanced wave activity at 10 hpa real? What is the implication if so?
- SSW events and the roles of GWs (interactions with the mean flow and planetary waves)
- Why the waves observed by AIRS are insentive to QBO at tropics?
- What are the implications on gravity wave drag parameterizations?

A longitudinal cross-section taken at the Antarctic Peninsula (July, 2002-2009)



Sep., 2002 - 2009




AIRS
AIRS
MLS
AIRS
AIRS
MLS
QBO Westerly
phase
QBO Easterly
phase